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Diptera species recorded for the first time in Slovakia found along the Danube floodplain

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Abstract. Four species of Diptera are recorded as new for the fauna of Slovakia: *Acrocera orbiculus* (Fabricius, 1787) (Acroceridae), *Conops insignis* Loew, 1848 (Conopidae), *Hermetia illucens* (Linnaeus, 1758) (Stratiomyidae), and *Tolmerus cowini* (Hobby, 1946) (Asilidae). The specimens were collected by means of Malaise trap, yellow pan trap, and sweep nets, in the years 2019–2022. Our findings highlight the value of the Danube floodplain from a conservation point of view. The appearance of *H. illucens* in Bratislava fits well with what is known about this synanthropic species.

Keywords. Acroceridae, Asilidae, Conopidae, flies, new record, Palearctic, Stratiomyidae

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Introduction

Larger Brachycera comprise popular fly families such as Acroceridae, Asilidae, Bombyliidae, Stratiomyidae, and several others. Among their species are those that have important ecological functions as pollinators, predators, parasitoids, parasites, vectors of diseases, or decomposers of organic matter. Thanks to their fairly large size, conspicuous appearance, day-time activity, and interesting life history, they are among the popular and fairly well studied flies (Stubbs and Drake 2014).

Thanks to the LIFE Programme, several restoration programs are underway in Slovakia, aiming at the restoration of the water regime, removal of invasive tree species, and restoration of traditional grazing and willow pollarding in the Slovak section of Danube floodplain (LIFE Restoration and management of Danube floodplain habitats, LIFE BeeSandFish, etc.). Alongside these management measures, monitoring of invertebrates has been carried out. Our research group has focused on larger Brachycera and Conopidae. During this monitoring, several species of insects were identified, which are represented here as new for Slovakia.

Methods

The insects were collected by means of Malaise trap (Virt) in 2019, as individual specimens along an established transect using an insect net in 2020–2022 (Apálsky ostrov, Bodíky, Číčov, and Veľký Lél), or by yellow pan trap (Bratislava-Karlova Ves) in 2022. The specimens collected by netting were preserved in 70% ethanol directly in the field. The specimens were pinned (pin size 1 or 000) or were glued to cardboard triangles. The collected materials were identified using the following keys: Acroceridae: Weinberg and Bächli (1997) and Chvála (1977); Asilidae: Wolff et al. (2018); Weinberg and Bächli (1995); Conopidae: van Veen (2010). Specimens were photographed using a Leica M205C binocular microscope or directly in the field. The materials are deposited in collection of the first author at the Institute of Zoology SAS (voucher numbers with the abbreviation UZSAV).

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Results

Family Acroceridae

***Acrocera orbiculus* (Fabricius, 1787)**

Material examined. SLOVAKIA – **Nitra Region** • Virt; 47°45′37.9″N, 018°20′20.2″E; 114 m alt.; 29.VII.2019; A. Purkart leg.; sand dune, Malaise trap; 1♂, pinned, UZSAV 309.

Identification. The genus *Acrocera* Meigen, 1803, has the antennae placed on the dorsal side of the head, in contrast to visually similar genus *Ogcodes* Latreille, 1796, which has them placed on the ventral side. *Acrocera orbiculus* was formerly placed in *Paracrocera* Mik, 1886, but Nartshuk (2000) has shown that to be a synonym of *Acrocera*. From related species, *A. orbiculus* differs in missing vein R_{2+3} and in having a largely yellowish abdomen with distinct transverse to triangular bands (Weinberg and Bächli 1997). According to Stubbs and Drake (2014), this species should have whitish postpronotal lobes and postalar calli and a line connecting them. However, in our specimen, the postalar calli are brownish, but this is likely a postmortem change partly caused by preparation of the specimen. Photographs of our specimen prior to preparation (not included here) show it to have the distinctive pattern as described by Stubbs and Drake (2014).

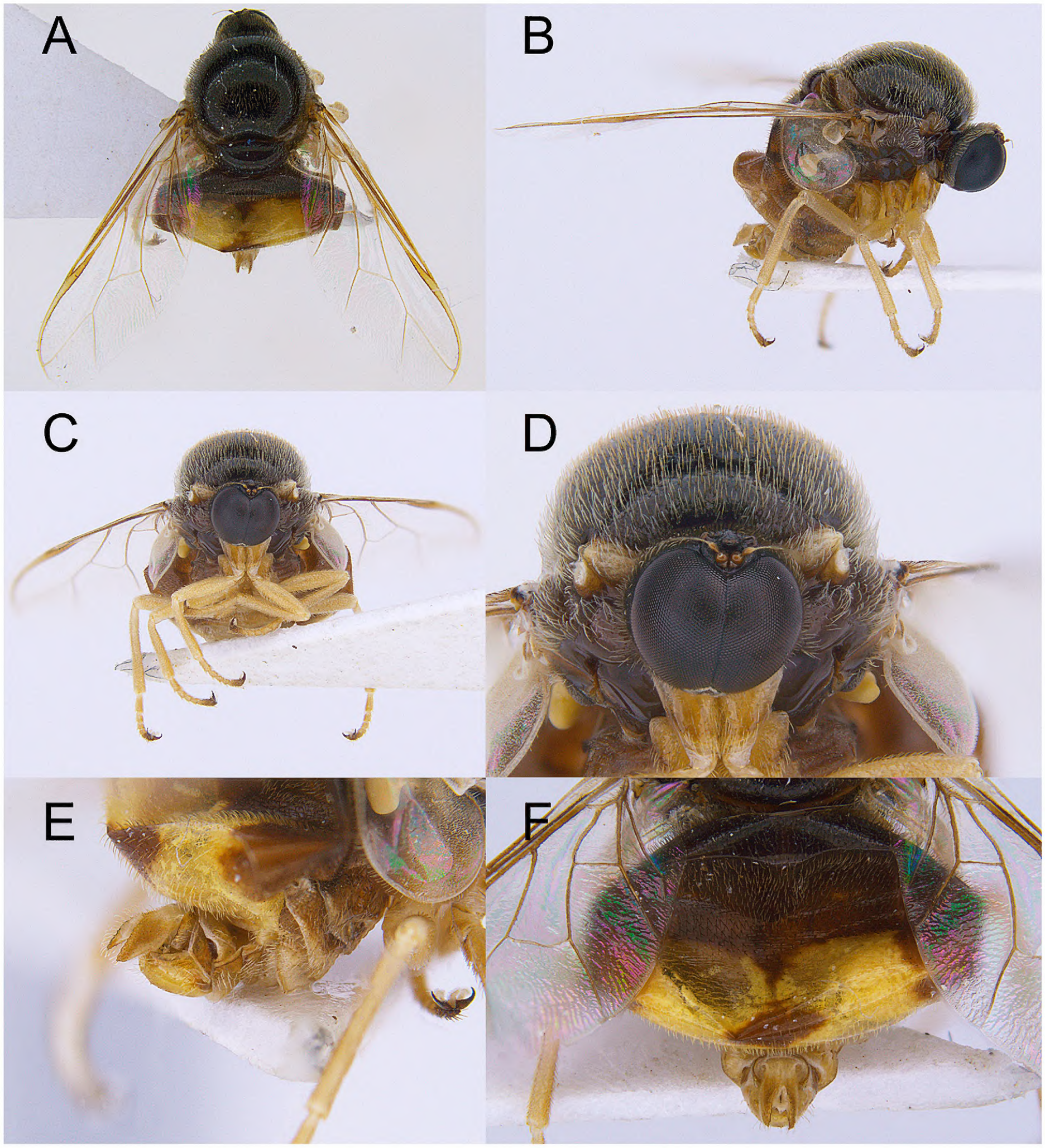

Figure 1. *Acrocera orbiculus*, male. **A.** Dorsal view. **B.** Lateral view. **C.** Frontal view. **D.** Head. **E.** Terminalia, lateral view. **F.** Terminalia, dorsal view.

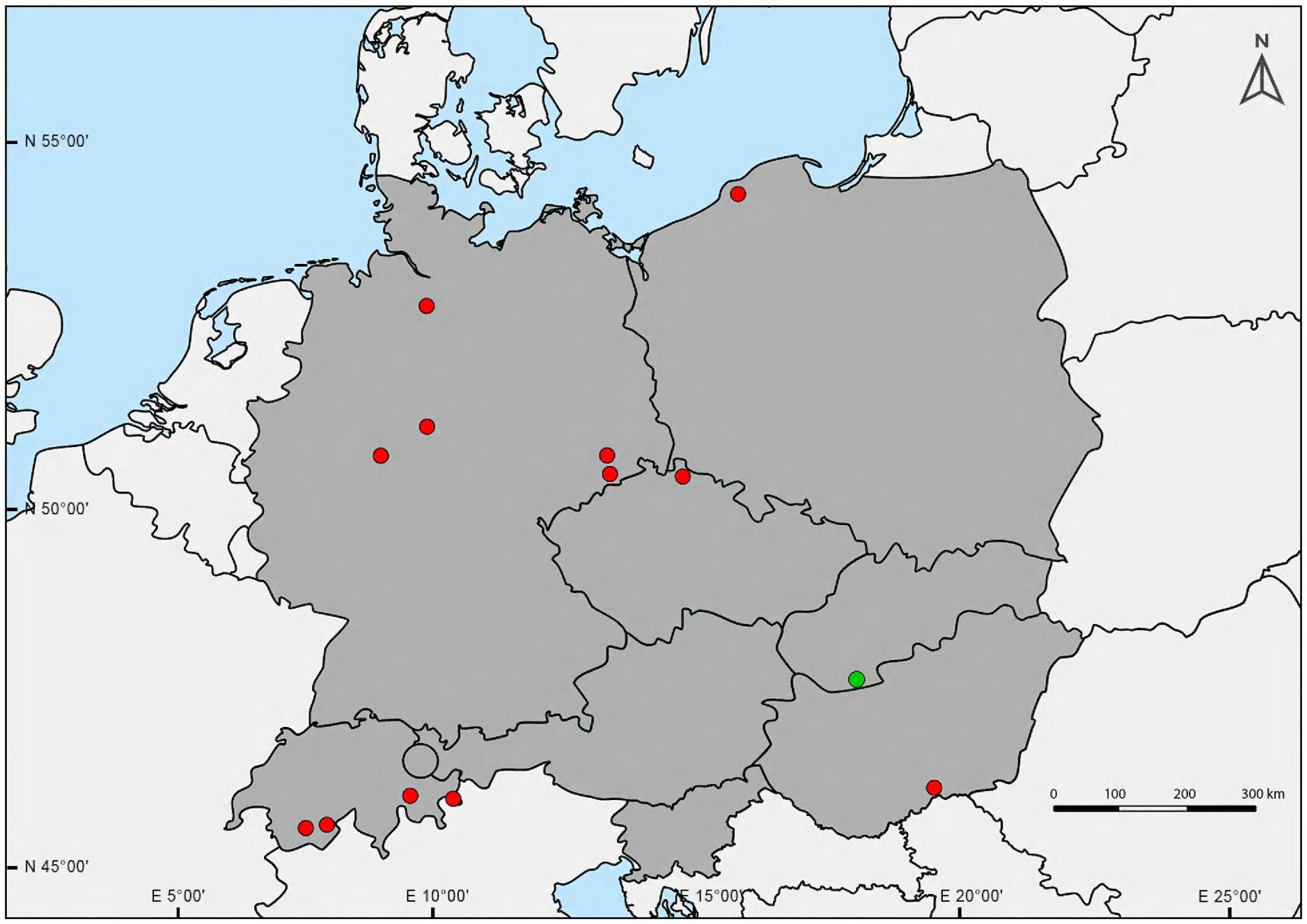

Figure 2. Geographic distribution of *Acrocera orbiculus* in Central Europe. Known occurrence (red circle). New records (green circle). Data from: Chvála and Vonička (2008); Majer (1977); Kehlmaier and Almeida (2014); Kehlmaier (2003); Stuke (2008); Trojan (1956); Weinberg and Bächli (1997).

Family Conopidae

***Conops insignis* Loew, 1848**

Observation. SLOVAKIA – **Nitra Region** • Zlatná na Ostrove, Veľký Lél Island; 47°45′07.90″N, 017°56′ 23.83″E; 110 m alt.; 19.7.2022; J. Zavřel obs.; pasture of domestic animals, on flowers of *Pulegium vulgare*, photographic record (Figs. 3, 4).

Identification. This species can be identified by following combination of characters: silvery stripe at the sides of thorax, black to brown scutellum, yellow face with small brown spot above antennal implant, and abdomen black with yellow dust bands (van Veen 2010) (Figs 3, 4).

Family Stratiomyidae

***Hermetia illucens* (Linnaeus, 1758)**

Materials examined. SLOVAKIA – Bratislava Region • Bratislava-Karlova Ves, Institute of Zoology SAS; 48° 10′18.3″N, 017°04′03.2″E; 193 m alt.; 21.VII.2022; J. Samay leg.; building interior, sweeping net; 1♀, pinned, UZSAV 310 • Bratislava-Karlova Ves, Kindergarten on Kolískova; 48°09′03.6″N, 017°03′19.5″E; 188 m alt.; 30.VIII.2022; M. Semelbauer leg.; yellow pan trap; 1♂, 1♀, pinned, UZSAV 311 • Bratislava Old Town; 48°08′ 57.9″N, 017°05′57.7″E; 8.X.2023; Ľ. Činovská leg.; reared from larvae found in compost heap on 24.VII.2023; 3♀, pinned, UZSAV312.

Figure 3. *Conops insignis*, female. Photo credit: Jan Zavřel.

Identification. *Hermetia illucens* is unique among Slovak species by its fairly large size, black body, very long antennae, and, in living specimens, intricate pattern on

Figure 4. Geographic distribution of *Conops insignis* in Central Europe. Known occurrence (red circle). New records (green circle). Data from: izeltlabuak.hu

compound eyes, brown-tinted wings, and two pale spots at the base of abdomen (Zeegers and Schulten 2022) (Figs 5, 6).

Family Asilidae

***Tolmerus cowini* (Hobby, 1946)**

Materials examined. SLOVAKIA – **Nitra Region** • Komárno, Apálsky ostrov Island; 47°47′14.4″N, 018°07′42.8″E; 109 m alt.; 15.VII.2020; M. Semelbauer leg.; alluvial meadow, sweeping net, 1♂, pinned, UZSAV 312 – **Trnava Region** • Bodíky; 47°54′27.0″N, 017°28′00.3″E; 116 m alt.; 13.VIII.2021, 24.VI.2022; M. Semelbauer leg.; cattle pasture in Danube inland delta, sweeping net; 2♀, 1♂, pinned, UZSAV 313 – **Nitra Region** • Číčov; 47°47′04.4″N, 017°44′06.6″E; 109 m alt.; 15.VII.2020, 17.VI.2021; M. Semelbauer leg.; alluvial meadow surrounded by fields, sweeping net; 3♀, 1♂, pinned, UZSAV 314 (Figs 7–9).

Identification. *Tolmerus cowini* is very similar to *T. cingulatus* (Fabricius, 1781) and *T. atricapillus* (Fallén, 1814). While males of *T. atricapillus* are easily distinguishable by their terminalia, females are problematic. *Tolmerus cowini* differs from these other species in having the dark hind femora with only an orange ring at the apex or sometimes an indistinct orange patch near the base, while *T. atricapillus* and *T. cingulatus*, a distinct orange stripe is present along the posterior side of hind femora. On the other hand, Smart (2005) used colour patterns of the fore- and mid-femora in a revised key largely based on specimens from British Isles. Males of *T. cingulatus* and *T. cowini* also differ in shapes of their gonostylus; in *T. cingulatus* the gonostylus is narrower and less angled at its base, while in *T. cowini* the gonostylus is broader and angled at base (Wolff et al. 2018; Speight 1987) (Figs 7, 8). Our specimens were identified by external morphology (colour pattern of hind femora), and a single male was dissected.

Discussion

Altogether, we record four species from four families as new to Slovakia. The family Acroceridae was represented in Slovakia by nine species (Roller 1997; Chvála 2009a), and our find of *Acrocera orbiculus* increases this number to 10. *Acrocera orbiculus* is distributed throughout Europe, including all countries neighbouring Slovakia, although exact localities from Austria are not known (Chvála 2009a; Nartshuk 2013). Therefore, the presence of this species in Slovakia is not surprising (Fig. 2).

The conopid genus *Conops* Linnaeus, 1758 was represented in Slovakia by nine species (Chvála 2009b; Semelbauer and Grechová 2019), and our record of *C. insignis* increases this number to 10. *Conops insignis* occurs in several European countries, including Spain, France, Italy, Sicily, Hungary, and Ukraine (Clements

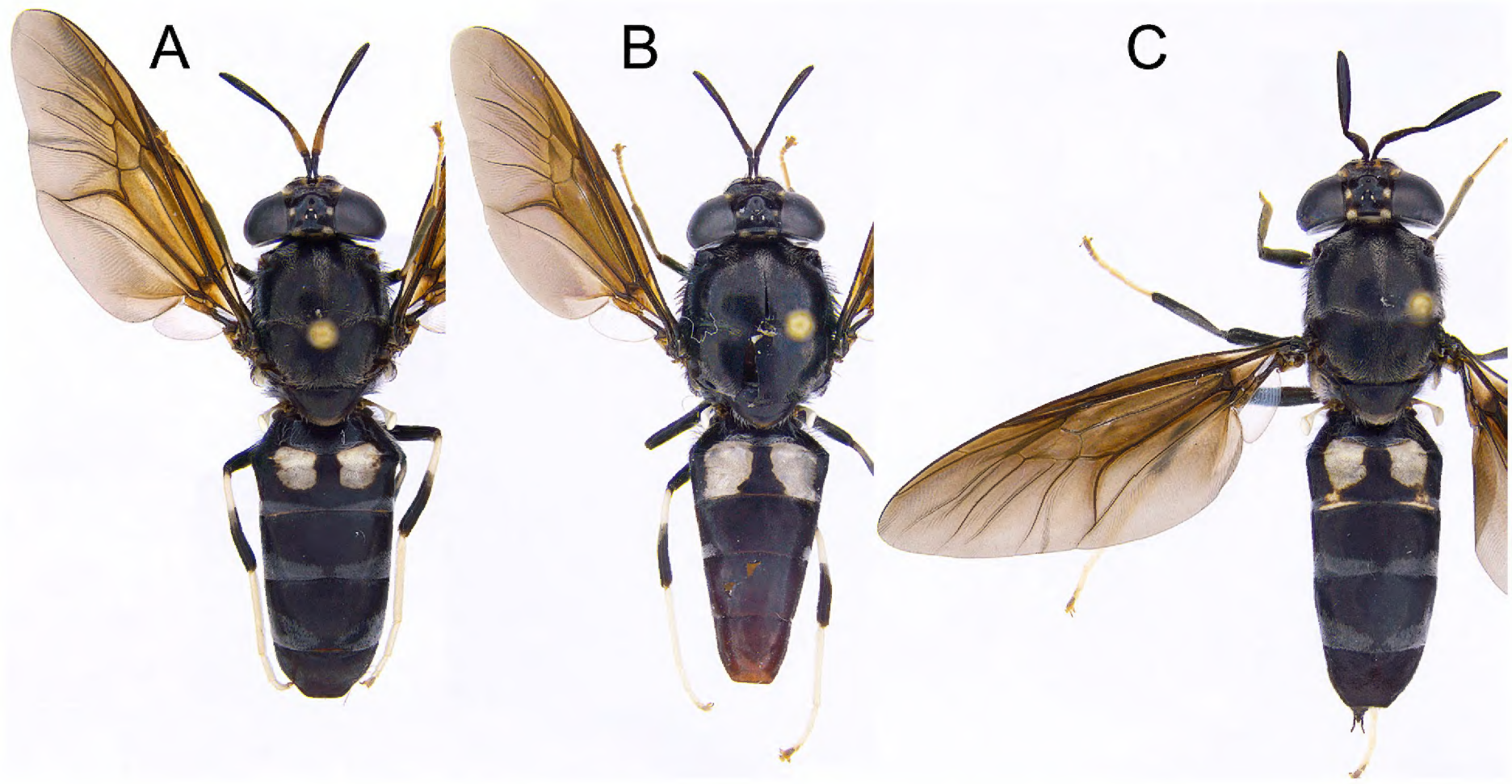

Figure 5. *Hermetia illucens*, habitus in dorsal view. **A.** Female, Kolískova. **B.** Male, Kolískova, **C.** Female, Institute of Zoology.

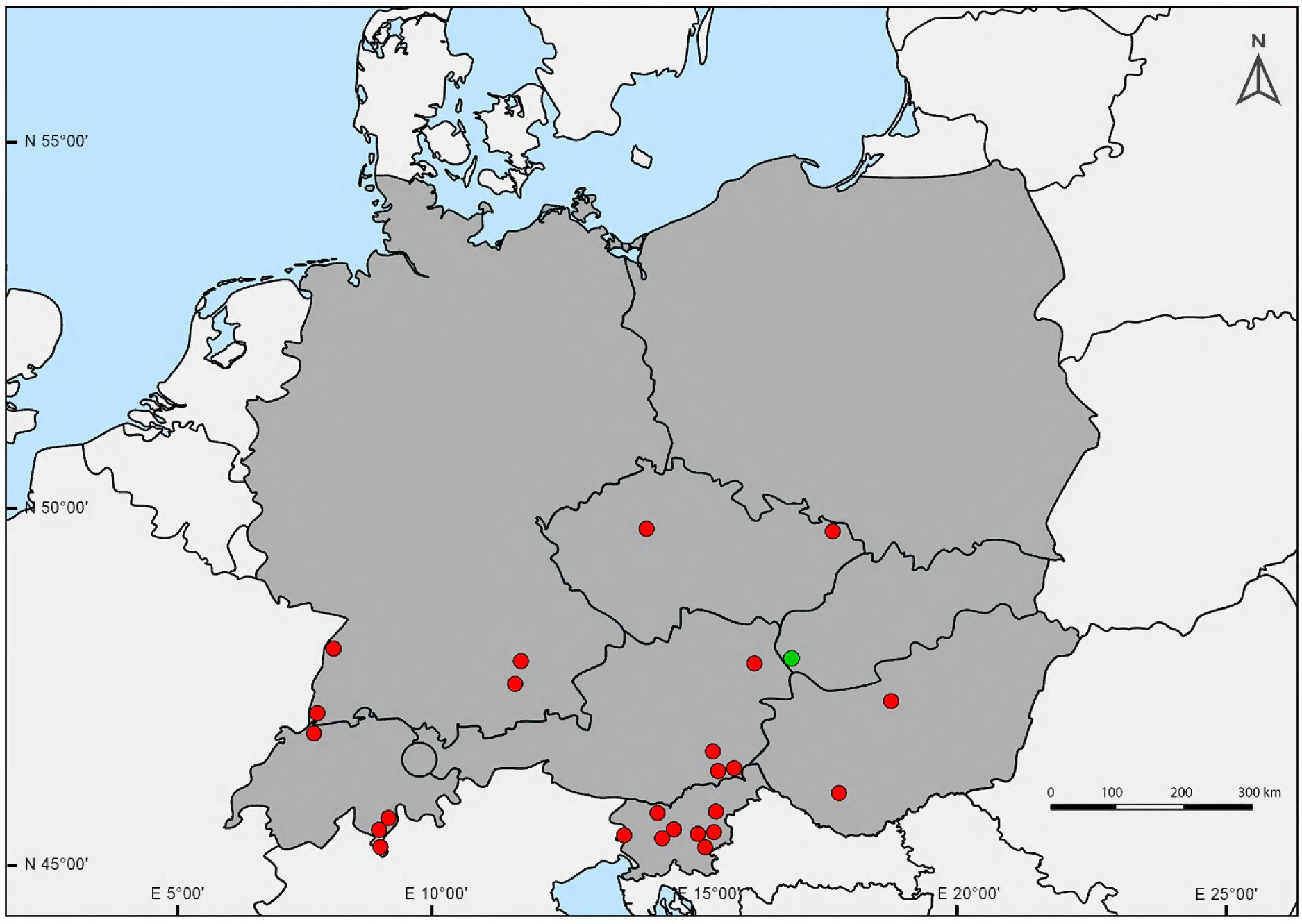

Figure 6. Geographic distribution of *Hermetia illucens* in Central Europe. Known occurrence (red circle). New records (green circle). Data from: Roháček and Hora (2013); Demetriou et al. (2022); GBIF.org; iNaturalist.org.

2013) (Fig. 4). Outside Europe, it is known from North Africa, Turkey, Iran, and Mongolia (Stuke et al. 2008; Khaghaninia and Kazerani 2014). The Slovakian site is used as pasture for domestic animals (cattle, horse, sheep, and goats) and is part of a valuable mosaic of alluvial meadows, pastures, and alluvial forests (Šibíková and Šibík 2021). Several specimens were observed and photographed on flowers of *Pulegium vulgare*.

The family Asilidae was represented in Slovakia by 101 species (Bosák 2009), which is now raised to 102. *Tolmerus cowini* is known from the British Isles (Cumbrian coast of Britain, Ireland, Isle of Man: Harvey 2018),

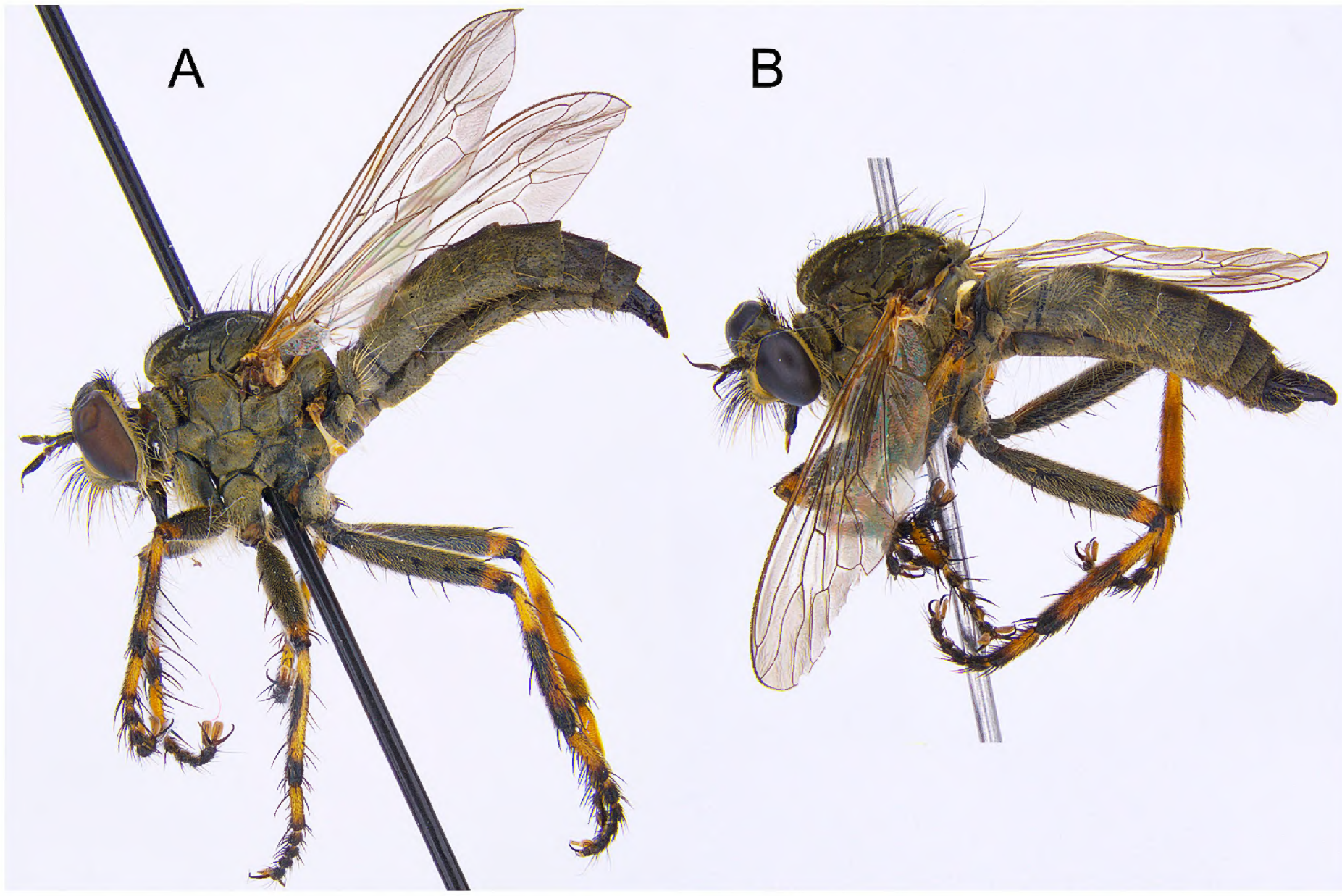

Figure 7. *Tolmerus cowini*, habitus in lateral view. **A.** Female. **B.** Male.

Figure 8. Gonostyli in lateral view. **A.** *Tolmerus cowini*. **B.** *T. cingulatus*.

France, Belgium, the Netherlands, Germany, Hungary, and Romania (Geller-Grimm 2013). In Germany, it is known from East Frisian Islands, Lower Rhine region, and Northeast German Lowland ("Seeburg am Süsen see" and Wöllnau: Wolff et al. 2018). This species inhabits coastal areas or surroundings of lowland rivers, often with bare ground and thickets of bracken and bramble (Stubbs and Drake 2014), or the contact zone between fallow fields and dry grassland (Wolff et al. 2018). An example of the habitat in the Lower Rhine region was given by Wolff et al. (2021). The sites in Slovakia mirror this general pattern, as all of them are located at a water body and can be characterized by a combination of grasslands and fallow land/fallow or bushes and solitary trees, although the bare ground is not present on Apálsky ostrov Island (Fig. 10A–C).

High habitat heterogeneity linked to natural processes such as flooding and traditional management, like pollarding or cattle grazing, has largely disappeared from the lowland landscape over the last decades (Varga et al. 2016; Šibíková-Petrášova et al. 2017). In combination with intensification of forestry and spread of invasive species, these changes threaten the diversity of Danube floodplains (Mikulová et al. 2020). Several

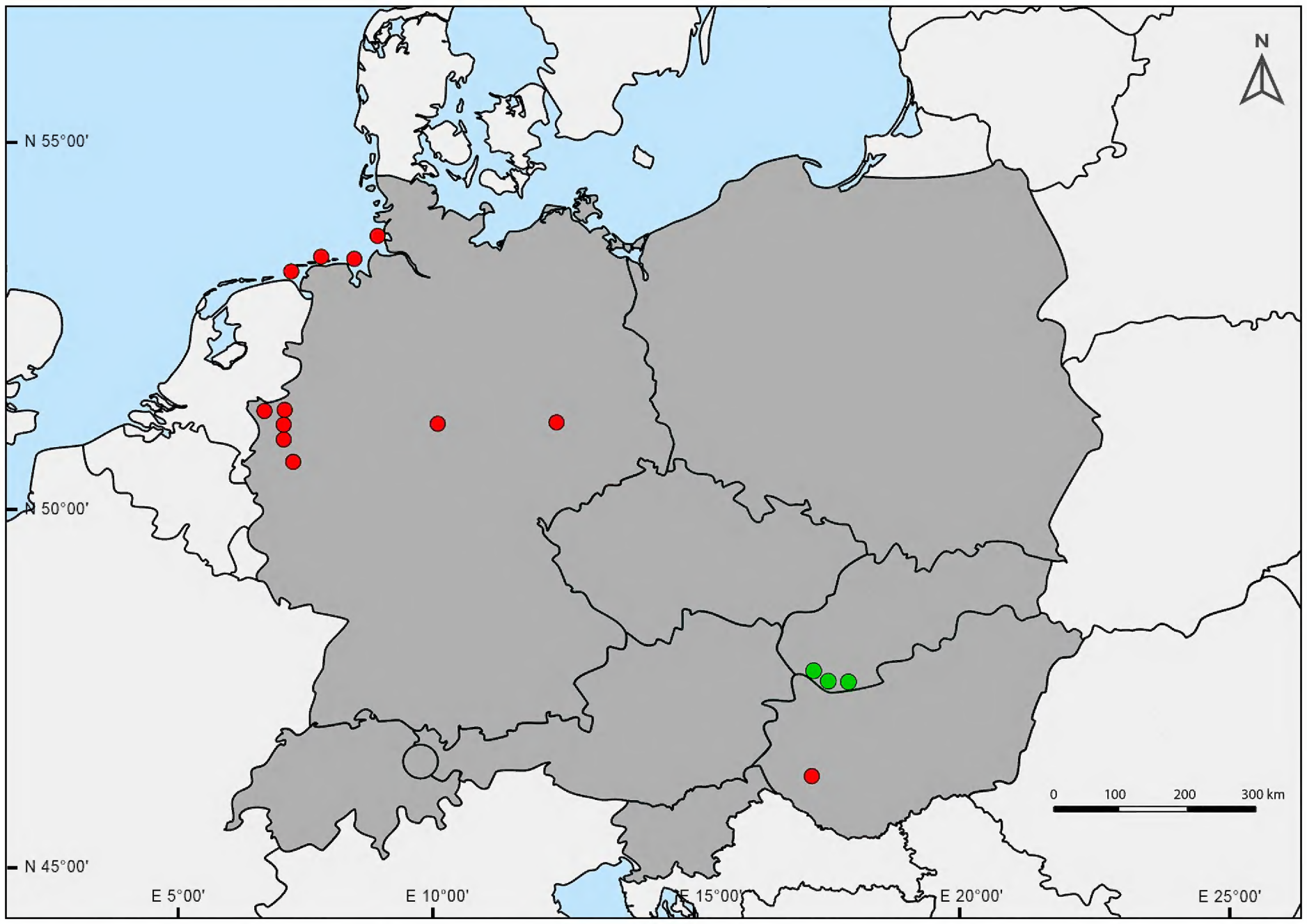

Figure 9. Geographic distribution of *Tolmerus cowini* in Central Europe. Known occurrence (red circle). New records (green circle). Data from: GBIF.org; Wolff et al. (2021); Speight (1987).

LIFE projects aim to reverse this change. The object of this article is not to evaluate the success of these projects, but thanks to these LIFE project, we can slightly add to the knowledge of the Slovak fauna. Besidse several species of flies, a new scoliid wasp, *Scolia galbulla* (Pallas, 1771), was recorded recently from the Island of Veľký Lél (Semelbauer and Bogusch 2020).

Hermetia illucens, Black Soldier Fly, is now almost cosmopolitan, synanthropic, and even domesticated in tropical, subtropical, and temperate regions. It probably originated in the American tropics (Ståhls et al. 2020). In Europe, it was first reported from Malta in 1926 and spread mainly along the western European Mediterranean coast after World War II. Recent observations have reported this species from the Balkan Peninsula and north-western France, with very few records from inland areas (Switzerland and southern Germany; summarized by Roháček and Hora (2013), including unpublished observations). One surprising find was from northern Czech Republic, where adults were reared from larvae found in manure heap in 2010 (Roháček and Hora 2013), although this species has not been subsequently confirmed there. More recently, it was found in the Netherlands (Smit et al. 2019), Belgium, the United Kingdom, southern Austria (Demetriou et al. 2022), on the Russian Black Sea coast (Krasnodarski krai) (Gladun 2019), and Germany (Doczkal 2017). Unpublished records are known from Hungary (Budapest and Kaposvár, south of Balaton, both 2022) (Fig. 6.) and Prague, Czech Republic (2020, https://www.inaturalist.org/taxa/82177-Hermetia-illucens).

Humans are largely responsible for the spread of *H. illucens* as a domesticated species. Although at one time considered a pest (it can cause myiasis), *H. illucens* is now widely used to recycle organic waste, to produce insect protein for pets, aquaculture, poultry, and livestock, and in research (Tomberlin and van Huis 2020). As it originated from the subtropics, this species' ability to survive in temperate regions has been questioned (Marshall et al. 2015). However, recent evidence shows that *H. illucens* is remarkably cold-resistant—flies, prepupae, and pupae can survive at 5 °C for several weeks (Spranghers et al. 2017)—and its occurrence in two or more consecutive years suggests that *H. illucens* is now established in several temperate regions of Europe (Demetriou et al. 2022). This species is expected to thrive in urban environments where it finds organic waste and a warmer microclimate. Our results are consistent with this; all specimens were caught in Bratislava, and three specimens were even reared from larvae found in a compost heap. Whether this species has become established in Slovakia is still uncertain, but considering several recent finds in western and central Europe, it seems likely that *H. illucens* will be recorded more often. As Demetriou et al. (2022) point out, this large, conspicuous species is an ideal object for citizen science.

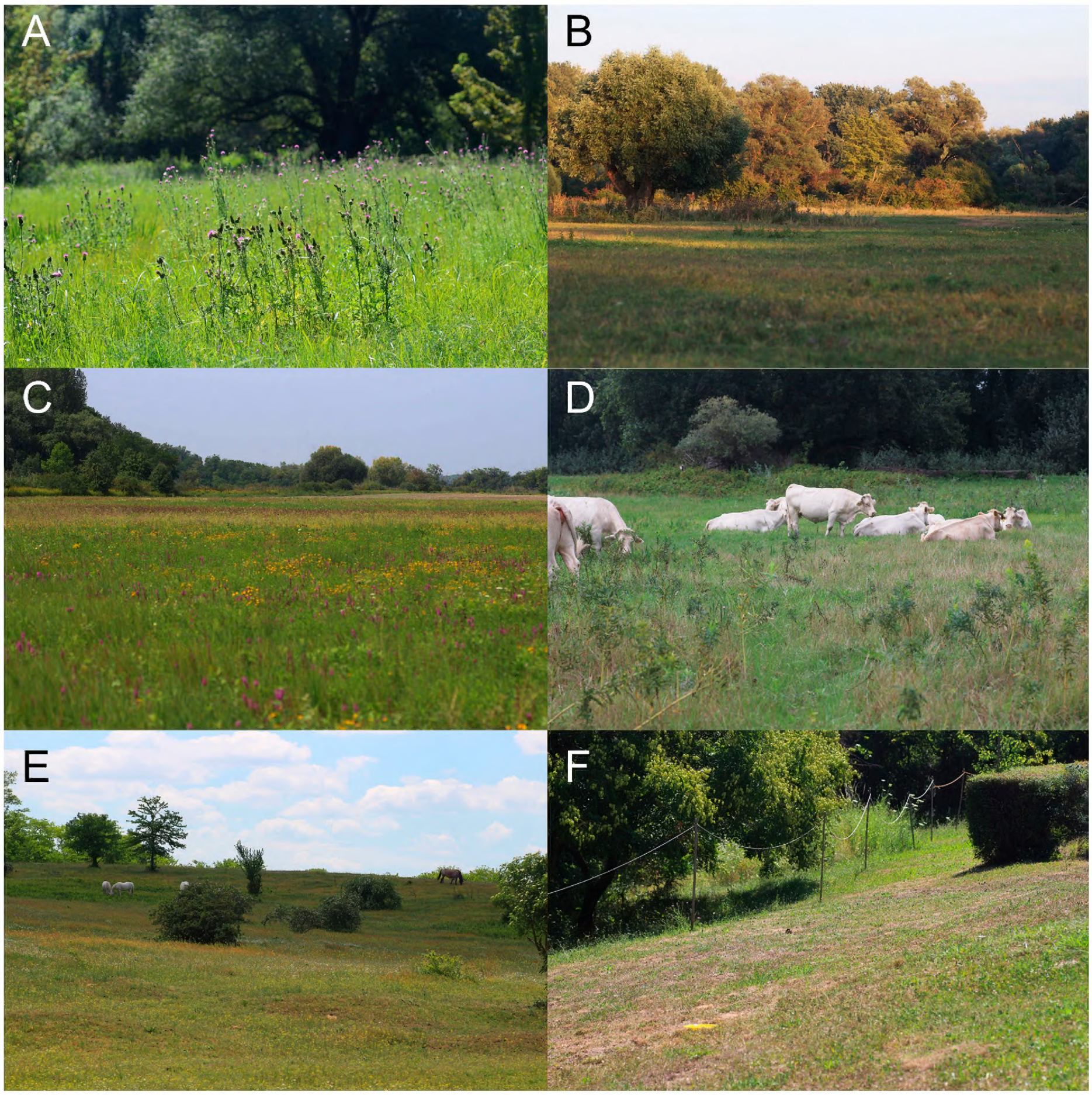

Figure 10. Habitats of the species reported. **A–C.** Habitat of *Tolmerus cowini*: (**A**) at Apálsky ostrov; (**B**) at Bodíky; (**C**) at Číčov. **D.** Habitat of *Conops insignis* at Veľký Lél Island. **E.** Habitat of *Acrocera orbiculus* in a horse pasture in Virt. **F.** Habitat of *Hermetia illucens* in Bratislava (Karlova Ves, Kindergarten on Kolískova).

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Authors Contributions

Conceptualization: MS. Investigation: JZ. Visualization: JS. Writing – original draft: MS. Writing – review and editing: JS.

References

Bosák J (2009) Asilidae Leach in Samouelle, 1819. In: Jedlička L, Kúdela M, Stloukalová V (Eds.) Checklist of Diptera of the Czech Republic and Slovakia. Electronic version 2. Comenius University, Bratislava, Slovakia. http://zoology.fns.uniba.sk/diptera2009. Accessed on: 2023-06-06.

Chvála M (1977) 37. ČEleď Kulatěnkovití – Acroceridae. In: Doskočil J (Ed.) Klíč zvířeny ČSSR V Dvoukřídlí. Československá Akademie Věd, Prague, Czech Republic, 166–167.

Chvála M (2009a) Acroceridae Leach, 1815, In: Jedlička L, Kúdela M, Stloukalová V (Eds) Checklist of Diptera of the Czech Republic and Slovakia. Electronic version 2. Comenius University, Bratislava, Slovakia. http://zoology.fns.uniba.sk/diptera2009. Accessed on: 2023-06-06.

Chvála M, Vonička P (2008) Kulatěnkovití (Diptera: Acro-

ceridae) Jizerských hor. Acroceridae (Diptera) of the Jizerské hory Mts (northern Bohemia, Czech Republic). Sborník Severočeského Muzea, Přírodní Vědy 26: 207–208.

Chvála M (2009b) Conopidae Latreille, 1802. In: Jedlička L, Kúdela M, Stloukalová V (Eds) Checklist of Diptera of the Czech Republic and Slovakia. Electronic version 2. Comenius University, Bratislava, Slovakia. http://zoology.fns.uniba.sk/diptera2009. Accessed on: 2023-06-06.

Clements DK (2013) Fauna Europaea: Conopidae. In: Pape T, Beuk P (Eds.) Fauna Europaea: Diptera, Brachycera, Fauna Europaea version 2017.06. https://fauna-eu.org. Accessed on: 2022-11-22.

Demetriou J, Kalaentzis K, Kazilas C, Kunz G, Muller B, Mostovski MB, Koutsoukos E (2022) An "alien" species on the loose: new records and updated distribution of the Black Soldier Fly *Hermetia illucens* in the Western Palearctic. Bulletin of Insectology 75 (1): 125–130.

Doczkal D (2017) Remarkable records of insects (Diptera, Hymenoptera, Lepidoptera) from the Grenzach project. In: Ssymank A, Doczkal D (Eds.) Biodiversität des südwestlichen Dinkelbergrandes und des Rheintals bei Grenzach-Wyhlen. Mauritiana 34: 821–835.

Geller-Grimm F (2013) Fauna Europaea: Asilidae. In: Pape T, Beuk P (Eds) Fauna Europaea: Diptera, Brachycera, Fauna Europaea version 2017.06. https://fauna-eu.org. Accessed on: 2022-11-28.

Gladun VV (2019) The first record of *Hermetia illucens* (Diptera, Stratiomyidae) from Russia. Nature Conservation Research 4(4): 111–113. https://doi.org/10.24189/ncr.2019.063

Harvey MC (2018) Provisional atlas of soldierflies and allies. Unpublished draft version. http://soldierflies.brc.ac.uk/sites/www.brc.ac.uk.soldierflies-and-allies/files/provisional%20atlas%20of%20soldierflies%20and%20allies%202018.pdf. Accessed on: 2023-06-06.

Kehlmaier C (2003) Beitrag zur Kugelfliegenfauna Deutschlands (Diptera: Acroceridae). Studia Dipterologica 10: 159–164.

Kehlmaier C, Almeida J M (2014) New host records for European Acroceridae (Diptera), with discussion of species limits of *Acrocera orbiculus* (Fabricius) based on DNA-barcoding. Zootaxa 3780 (1): 135–152. https://doi.org/10.11646/zootaxa.3780.1.5

Khaghaninia S, Kazerani F (2014) Faunistic study of the subfamily Conopinae (Diptera: Conopidae) in Arasbaran forests, with two new records for Iranian fauna. Journal of Crop Protection 3 (4): 459–465.

Majer J (1977) 46 ábrával. Katonalegyek-gömblegyek. Stratiomydae–Acroceridae. Fauna Hungariae 129: 1–77.

Marshall SA, Woodley NE, Hauser M (2015) The historical spread of the Black Soldier Fly, *Hermetia illucens* (L.) (Diptera, Stratiomyidae, Hermetiinae), and its establishment in Canada. The Journal of the Entomological Society of Ontario 146: 51–54.

Mikulová K, Jarolímek I, Šibík J, Bacigál T, Šibíková M (2020) Long-term changes of softwood floodplain forests—did the disappearance of wet vegetation accelerate the invasion process? Forests 11 (11): 1218. https://doi.org/10.3390/f11111218

Nartshuk EP (2000) On synonymy of *Acrocera* Meigen and *Paracrocera* Mik (Diptera: Acroceridae). Zoosystematica Rossica 8 (2): 300.

Nartshuk E P (2013) Fauna Europaea: Acroceridae. In: Pape T Beuk P (Eds.) Fauna Europaea: Diptera, Brachycera, Fauna Europaea version 2017.06. https://fauna-eu.org. Accessed on: 2022-11-22.

Roháček J, Hora M (2013) A northernmost European record of the alien Black Soldier Fly *Hermetia illucens* (Linnaeus, 1758) (Diptera: Stratiomyidae). Čas Slez Muz Opava (A) 62: 101–106. https://doi.org/10.2478/cszma-2013-0011

Roller L. (1997) Faunistic records from Slovakia. Diptera: Acroceridae. Entomological Problems 28 (2): 140.

Semelbauer M, Grechová D (2019) Silver Fly *Parochthiphila spectabilis* (Loew, 1858) (Diptera, Chamaemyiidae) and Thick-headed Fly *Conops silaceus* Wiedemann in Meigen, 1824 and *Leopoldius valvatus* Kröber, 1914 (Diptera, Conopidae) new for Slovakia. Entomofauna Carpathica 31 (2): 90–92.

Semelbauer M, Bogusch P (2020) The first finding of *Scolia galbula* (Pallas, 1771) (Hymenoptera, Scoliidae) from Slovakia. Entomofauna Carpathica 32 (2): 98–100.

Smart MJ (2005) Identification of females of the smaller British species of *Machimus* sensu lato (Diptera, Asilidae) with a note on the morphology of the ventral abdominal and thoracic plates. Dipterists Digest 12: 61–68.

Smit J, Zeegers T, Cramer T (2019) Exotische zwarte soldatenvlieg *Hermetia illucens* duikt op in Nederland (Diptera: Stratiomyidae). Nederlandse Faunistische Mededelingen 53: 11–15.

Speight M C (1987) Re-affirmation of the status of *Machimus cowini*, (Diptera: Asilidae), as a separate species, with a key to distinguish the male from males of some related species. The Irish Naturalists' Journal 22 (7): 296–304.

Spranghers T, Noyez A, Schildermans K, De Clerq P (2017) Cold hardiness of the Black Soldier Fly (Diptera: Stratiomyidae). Journal of Economical Entomology 110 (4): 1501–1507. https://doi.org/10.1093/jee/tox142

Ståhls G, Meier R, Sandrock C, Hauser M, Šašić Zorić L, Laiho E, Aracil A, Doderović J, Badenhorst R, Unadirekkul P, Mohd Adom NAB, Wein L, Richards C, Tomberlin JK, Rojo S, Veselić S, Parviainen T (2020) The puzzling mitochondrial phylogeography of the Black Soldier Fly (*Hermetia illucens*), the commercially most important insect protein species. BMC Evolutionary Biology 20 (1): 60. https://doi.org/10.1186/s12862-020-01627-2

Stuke JH (2008) Die Ibisfliegen, Kugelfliegen, Hummelschweber, Schnepfenfliegen und Stilettfliegen Niedersachsens und Bremens (Diptera: Acroceridae, Athericidae, Bombyliidae, Rhagionidae, Therevidae). Braunschweiger Naturkundliche Schriften 8: 235–259.

Stuke JH, Hayat RÜ, Özbek HI (2008) Records of notable Conopidae (Diptera) from Turkey. Faunistische Abhandlungen 26: 109–117.

Šibíková M, Šibík J (2021) Monitoring dopadu projektových aktivít na biotopy. Čiastková správa – rok 2021, LIFE14 NAT/SK/001306 Obnova a manažment dunajských lužných biotopov, 40 pp.

Petrášová-Šibíková M, Matečný I, Uherčíková E, Pišút P, Kubalová S, Valachovič M, Hodálová I, Mereďa P,

Bisbing SM, Medvecká J (2017) Effect of the Gabčíkovo Waterworks (Slovakia) on riparian floodplain forest ecosystems in the Danube inland delta: vegetation dynamics and trends. Biologia 72 (7): 722–734. https://doi.org/10.1515/biolog-2017-0082

Tomberlin JK, Huis A van (2020) Black soldier fly from pest to 'crown jewel' of the insects as feed industry: a historical perspective. Journal of Insects as Food and Feed 6 (1): 1–4. https://doi.org/10.3920/JIFF2020.0003

Trojan P (1956) *Oncodes reginae* sp. n. oraz uwagi o gatunkach europejskich z rodziny Cyrtidae (Diptera). Annales Zoologici 16 (8): 73–79.

Varga A, Molnár Z, Biró M, Demeter L, Gellény K, Miókovics E, Molnár Á, Molnár K, Ujházy N, Ulicsni V, Babai D (2016) Changing year-round habitat use of extensively grazing cattle, sheep and pigs in East-Central Europe between 1940 and 2014: Consequences for conservation and policy. Agriculture, Ecosystems & Environment 234: 142–153. https://doi.org/10.1016/j.agee.2016.05.018

Veen M van (2010) Conopidae genera key—Northwest Europe. Faunist. https://home.hccnet.nl/mp.van.veen/conopidae/ConGenera.html. Accessed on: 2022-7-12.

Weinberg M, Bächli G (1995) Insecta Helvetica, Fauna 11: Diptera, Asilidae. Musée d'Histoire naturelle, Neuchâtel, Switzerland, 124 pp. https://doi.org/10.1002/mmnd.19960430216

Weinberg M, Bächli G (1997) Faunustik und Taxonomie der Acroceriden (Diptera) der Schweiz. Mitteilungen der Schweizerischen Entomologischen Gesellschaft 70: 209–224. https://doi.org/10.5169/seals-402669

Wolff D, Gebel M, Geller-Grimm F (2018) Die Raubfliegen Deutschlands. Entdecken – Beobachten – Bestimmen. Quelle und Meyer, Wiebellsheim, Germany, 339 pp.

Wolff D, Hable J, Hoffmann M, Gebel M, Marschang A, Amshoff J, Rühlke L (2021) Raubfliegen (Diptera, Asilidae) aus Deutschland, Online-Nachweise XV. http://www.asilidae.de/privathp/papers/asil2020.pdf. Accessed on: 2023-06-06.

Zeegers T, Schulten A (2022) Field guide to flies with three pulvilli, families of Homeodactyla of Northwest Europe. Stichting Jeugdbondsuitgeverij, Amsterdam, the Netherlands, 256 pp.